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The deep scattering layer micronektonic fish faunas of the Atlantic mesopelagic ecoregions with comparison of the corresponding decapod shrimp faunas

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ABSTRACT

Three hundred and twenty-nine species of micronektonic fishes were identified in 1040 midwater trawl collections taken between 1963 and 1974 from the North and South Atlantic, the Mediterranean, the Caribbean and the Gulf of Mexico. The target of most tows was the deep scattering layer, and consequently the dominant species in the material were those that were concentrated in the layer. The results only generally confirm the 11 Atlantic mesopelagic ecoregions previously recognized. The geometric mean of the proportion of joint occurrences (GMPJO) of species with tows within each ecoregion was used to characterize the faunas of the ecoregions. The ecoregion affinities of fishes were compared to those of decapod shrimp in the same collections. The fish and shrimp faunas of ecoregions could be distinguished by GMPJO values, but the ranges of species favoring each ecoregion varied widely in extent and did not conform well to ecoregion boundaries or features of circulation. This suggests that co-occurring species respond differently to the physical properties and resulting biological factors defining mesopelagic ecoregions.

1. Introduction

Teleost fishes are a major component in abundance and biomass of the taxonomically diverse assemblage of the relatively small (2–10 cm) but actively swimming organisms termed micronekton. The micronekton is part of a pelagic community of species ranging in a continuum in size from nannoplankton to large fishes and cetaceans. The fishes, crustaceans, cephalopods and other less abundant groups comprising the micronekton are a critical link between the mesozooplankton and the higher trophic levels including larger fishes, seabirds and marine mammals (Brodeur et al., 2004). Many perform extensive diel migrations from mesopelagic depths during the day into the epipelagic zone at night and thus are an important conduit for transfer of organic matter between depths. Costello and Breyer (2016) estimate that the mesopelagic fauna intercept about 90% of organic carbon fixed in the euphotic zone and may contribute as much as 30% of ocean carbon dioxide production.

Midwater fishes have been the subject of numerous regional faunal studies in the Atlantic (e.g., Backus et al., 1969, 1970; Jahn and Backus, 1976; Badcock and Merrett, 1977; Hulley and Krefft, 1985; Figueroa et al., 1998; Sutton et al., 2010; Sutton. et al., 2013; Cook et al., 2013; Olivar et al., 2017) and in adjoining waters of the Mediterranean (Olivar et al., 2012; Bernal et al., 2015) and Gulf of Mexico (Gartner et al., 1987; Hopkins and Sutton, 1998). Krefft (1976) described distributional patterns in the Atlantic of larger oceanic fish species taken with an Engel trawl, a device with a much larger opening and coarser mesh than those used in studies of the micronekton. Geographical ranges in the Atlantic have been outlined for only some families (Ebeling, 1962; Ebeling and Weed, 1963; Gibbs, 1969; Johnson, 1974; Backus et al., 1977; Badcock and Baird, 1980; Mora Porteiro, 2005).

This study encompassed all species identified in 1040 midwater-trawl collections taken in the North and South Atlantic, the Mediterranean, the Caribbean and the Gulf of Mexico between 1963 and 1974 by ships of the Woods Hole Oceanographic Institution (WHOI).

The primary objective of the WHOI program, directed by oceanographer Richard H. Backus, was to identify the relationship between midwater fish distribution and sound scattering levels (Backus and Craddock, 1977). To accomplish this, most net hauls were at or close to the sound scattering layer. The lack of systematic sampling of the water column by the WHOI program precludes comparisons of total abundance between locations, and geographic analysis of data here is based

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Table 1
Numbers (#) and duration (h) of IKMT tows made by WHOI between 1961 and 1974 summarized by ecoregion, depth stratum (m) and photoperiod (Night, Day, Twilight). Obl = oblique.

1 - Arctic, Total tows = 3														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	-	-	-	-	-	-	-	-	-	1 2.3	-	-	-	-
D# h	-	-	-	-	-	-	-	-	-	-	-	1 1.1	-	-
T# h	-	-	-	-	-	-	1 1.6	-	-	-	-	-	-	-
2 - Northwest Atlantic-Subarctic, Total tows = 120														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	11 18.6	12 35.0	8 13.9	12 24.7	5 6.7	4 6.5	2 3.4	-	1 2.4	1 4.3	-	-	1 5.4	7 29.3
D# h	-	-	-	-	3 8.1	-	1 2.7	7 21.2	7 26.9	5 12.5	6 17.5	3 7.2	5 16.9	14 56.2
T# h	-	1 1.7	-	-	2 2.7	-	2 3.9	-	-	-	-	-	-	-
3 - North Atlantic Drift, Total tows = 75														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	11 30.8	10 24.7	5 11.8	7 14.2	5 9.3	1 1.3	3 9.4	2 6.4	-	-	1 1.9	1 2.3	-	1 1
D# h	-	-	-	-	-	-	2 7.7	6 20.0	6 21.7	3 8.3	4 11.0	3 7.2	1 3.8	-
T# h	-	-	-	-	-	-	-	1 1.6	-	-	1 2.6	-	-	1 2.7
4 - Central North Atlantic, Total tows = 528														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	31 70.4	67 151	46 91.3	51 104	23 51.4	12 28.4	10 25.7	5 7.7	7 28.1	2 4.0	1 2.6	2 6.7	6 28.5	139 269
D# h	1 1.0	1 3.2	1 3.4	2 6.9	4 7.4	2 7.6	13 36.3	19 56.1	21 70.1	17 61.5	6 20.4	11 33.9	9 31.3	3 16.9
T# h	-	-	-	2 3.2	1 1.3	3 7.1	3 10.2	5 15.0	-	1 2.5	-	1 3.6	-	-
5 - Tropical-West Equatorial Atlantic, Total tows = 70														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	2 2.4	11 23.9	14 38.9	6 13.3	2 5.0	3 9.4	11 40.2	2 5.5	2 6.8	-	1 4.3	-	2 10.8	1 6.3
D# h	1 0.7	-	-	1 2.5	1 4.1	-	2 7.4	5 16.8	-	1 2.5	-	-	2 11.7	-
6 - South Atlantic, Total tows = 74														
N# h	1 1.8	9 12.0	11 14.3	12 18.5	11 16.0	3 3.2	2 3.2	3 5.8	6 10.6	4 7.8	3 6.6	1 3.3	2 4.3	-
D# h	-	-	-	1 3.7	-	-	1 2.4	-	1 3.0	-	-	-	1 2.0	2 10.3
7 – Mauritania-Cape Verde, Total tows = 53														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
D# h	-	11 19.2	2 3.8	10 18.7	5 9.2	4 7.3	4 7.6	-	-	-	-	-	-	1 0.8
N# h	-	-	-	-	-	-	1 3.2	4 9.1	2 5.1	1 2.8	4 11.7	1 3.2	2 6.7	1 0.6
8 - Guinea Basin-East Equatorial Atlantic, Total tows = 9														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	-	4 7.8	1 2.0	3 5.7	-	1 3.0	-	-	-	-	-	-	-	-
9 - Benguela Upwelling, Total tows = 5														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	-	-	1 1.8	1 1.1	-	-	-	-	-	-	-	1 1.8	-	-
D# h	-	-	-	-	-	-	-	1 1.9	-	1 1.8	-	-	-	-
10 - Gulf of Mexico, Total tows = 23														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	-	3 10.5	2 7.0	2 7.2	1 3.1	2 6.1	-	-	2 6.1	-	-	-	-	-
D# h	-	-	-	-	1 3.0	1 2.9	-	4 15.0	2 7.7	2 7.4	-	-	-	1 6.3
11- Mediterranean,Total tows = 80														
Stra tum	25–50	51–75	76–100	101–150	151–200	201–250	251–300	301–400	401–500	501–600	601–700	701–800	> 800	Obl
N# h	6 15.3	12 26.6	11 27.3	14 37.1	10 27.4	2 3.8	1 1.9	1 3.3	-	-	-	-	-	-
D# h	-	-	-	-	-	-	-	2 6.2	3 9.3	3 9.0	2 5.9	1 4.6	2 8.4	3 16.1
T# h	-	-	-	1 1.0	-	-	3 10.1	2 8.0	1 2.4	-	-	-	-	-